

them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors which could create additional hazards.

(d) Compliance with the requirements of paragraph (b)(2) of this section must be shown by analysis and, where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider—

(1) Possible modes of failure, including malfunctions and damage from external sources;

(2) The probability of multiple failures and undetected failures;

(3) The resulting effects on the rotorcraft and occupants, considering the stage of flight and operating conditions; and

(4) The crew warning cues, corrective action required, and the capability of detecting faults.

(e) For Category A rotorcraft, each installation whose functioning is required by this subchapter and which requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:

(1) Loads connected to the system with the system functioning normally.

(2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.

(3) Essential loads, after failure of—

(i) Any one engine, on rotorcraft with two engines; and

(ii) Any two engines, on rotorcraft with three or more engines.

(f) In determining compliance with paragraphs (e)(2) and (3) of this section, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operations authorized. Loads not required for controlled flight need not be considered for the two-engine-inoperative condition on rotorcraft with three or more engines.

(g) In showing compliance with paragraphs (a) and (b) of this section with regard to the electrical system and to equipment design and installation, critical environmental conditions must be considered. For electrical genera-

tion, distribution, and utilization equipment required by or used in complying with this subchapter, except equipment covered by Technical Standard Orders containing environmental test procedures, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aircraft.

(h) In showing compliance with paragraphs (a) and (b) of this section, the effects of lightning strikes on the rotorcraft must be considered.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5084, 29 FR 16150, Dec. 3, 1964, as amended by Amdt. 29-14, 42 FR 36972, July 18, 1977; Amdt. 29-24, 49 FR 44438, Nov. 6, 1984; Amdt. 29-40, 61 FR 21908, May 10, 1996]

#### INSTRUMENTS: INSTALLATION

##### § 29.1321 Arrangement and visibility.

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be easily visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.

(b) Each instrument necessary for safe operation, including the airspeed indicator, gyroscopic direction indicator, gyroscopic bank-and-pitch indicator, slip-skid indicator, altimeter, rate-of-climb indicator, rotor tachometers, and the indicator most representative of engine power, must be grouped and centered as nearly as practicable about the vertical plane of the pilot's forward vision. In addition, for rotorcraft approved for IFR flight—

(1) The instrument that most effectively indicates attitude must be on the panel in the top center position;

(2) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the attitude instrument;

(3) The instrument that most effectively indicates airspeed must be adjacent to and to the left of the attitude instrument; and

(4) The instrument that most effectively indicates altitude or is most frequently utilized in control of altitude must be adjacent to and to the right of the attitude instrument.

(c) Other required powerplant instruments must be closely grouped on the instrument panel.

(d) Identical powerplant instruments for the engines must be located so as to prevent any confusion as to which engine each instrument relates.

(e) Each powerplant instrument vital to safe operation must be plainly visible to appropriate crewmembers.

(f) Instrument panel vibration may not damage, or impair the readability or accuracy of, any instrument.

(g) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5084, 29 FR 16150, Dec. 3, 1964, as amended by Amdt. 29–14, 42 FR 36972, July 18, 1977; Amdt. 29–21, 48 FR 4391, Jan. 31, 1983]

#### **§ 29.1322 Warning, caution, and advisory lights.**

If warning, caution or advisory lights are installed in the cockpit they must, unless otherwise approved by the Administrator, be—

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the color differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.

[Amdt. 29–12, 41 FR 55474, Dec. 20, 1976]

#### **§ 29.1323 Airspeed indicating system.**

For each airspeed indicating system, the following apply:

(a) Each airspeed indicating instrument must be calibrated to indicate true airspeed (at sea level with a stand-

ard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) Each system must be calibrated to determine system error excluding airspeed instrument error. This calibration must be determined—

(1) In level flight at speeds of 20 knots and greater, and over an appropriate range of speeds for flight conditions of climb and autorotation; and

(2) During takeoff, with repeatable and readable indications that ensure—

(i) Consistent realization of the field lengths specified in the Rotorcraft Flight Manual; and

(ii) Avoidance of the critical areas of the height-velocity envelope as established under § 29.87.

(c) For Category A rotorcraft—

(1) The indication must allow consistent definition of the critical decision point; and

(2) The system error, excluding the airspeed instrument calibration error, may not exceed—

(i) Three percent or 5 knots, whichever is greater, in level flight at speeds above 80 percent of takeoff safety speed; and

(ii) Ten knots in climb at speeds from 10 knots below takeoff safety speed to 10 knots above  $V_Y$ .

(d) For Category B rotorcraft, the system error, excluding the airspeed instrument calibration error, may not exceed 3 percent or 5 knots, whichever is greater, in level flight at speeds above 80 percent of the climbout speed attained at 50 feet when complying with § 29.63.

(e) Each system must be arranged, so far as practicable, to prevent malfunction or serious error due to the entry of moisture, dirt, or other substances.

(f) Each system must have a heated pitot tube or an equivalent means of preventing malfunction due to icing.

[Doc. No. 5084, 29 FR 16150, Dec. 3, 1964 as amended by Amdt. 29–3, 33 FR 970, Jan. 26, 1968; Amdt. 29–24, 49 FR 44439, Nov. 6, 1984; Amdt. 29–39, 61 FR 21901, May 10, 1996]

#### **§ 29.1325 Static pressure and pressure altimeter systems.**

(a) Each instrument with static air case connections must be vented to the